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REVIEW OF VOLUNTARY AGREEMENTS PROGRAM

UNDER THE

DEFENSE PRODUCTION ACT

TITANIUM METAL INDUSTRY

REPORT DATED MAY 9, 1957

BY THE

ATTORNEY GENERAL

COMMITTEE ON BANKING AND CURRENCY
UNITED STATES SENATE

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STATEMENT OF THE CHAIRMAN

Under section 708 (e) of the Defense Production Act of 1950, as amended, the Attorney General is directed to review the administration of that act. This review is for the purpose of determining any factors which may tend to eliminate competition, create or strengthen monopolies, injure small business, or otherwise promote undue concentration of economic power in the course of administration of the act.

The Defense Production Act Amendments of 1955 require the Attorney General to report at least once every 3 months, and to include in these reports a statement on the continuing review, required of the Attorney General under the 1955 amendments, of the voluntary agreements approved under section 708 of the act.

Previous quarterly reports have been made available as committee prints on February 28, 1956 (reports dated November 9, 1955; February 9, 1956, tax amortization certificates and the petroleum industry, and February 20, 1956); August 10, 1956 (reports dated May 9 and August 9, 1956, tax amortization certificates in the nitrogen industry); December 6, 1956 (report dated November 9, 1956, Government-sponsored industrial research), and February 13, 1957 (report dated February 9, 1957, stockpiling).

The Attorney General's report dated May 9, 1957, contains a review of the titanium metal industry, and a review of recent activities under the voluntary agreements approved by the Director of the Office of Defense Mobilization and the Attorney General under section 708 of the Defense Production Act of 1950, as amended.

This report is of importance and interest to the committee and to the Senate and to the public.

J. W. FULBRIGHT, *Chairman.*

REPORT OF THE ATTORNEY GENERAL PURSUANT TO SECTION 708 (e) OF THE DEFENSE PRODUCTION ACT OF 1950, AS AMENDED

MAY 9, 1957.

To the President of the United States of America and the Senate and House of Representatives of the United States of America in Congress assembled:

I have the honor to submit a report in compliance with section 708 (e) of the Defense Production Act of 1950, as amended. That provision directs the Attorney General to make—

> * * * surveys for the purpose of determining any factors which may tend to eliminate competition, create or strengthen monopolies, injure small business, or otherwise promote undue concentration of economic power in the course of the administration of this Act. Such surveys, and the reports hereafter required, shall include studies of the voluntary agreements and programs authorized by this section. The Attorney General shall submit to the Congress and the President within ninety days after the approval of this Act, and at least once every three months, reports setting forth the results of such surveys and including such recommendations as he may deem desirable.

This report, in two parts, (1) reviews the competitive consequences of defense expansion of the titanium metal industry and (2) relates the present status of the outstanding voluntary agreements and programs under the Defense Production Act.

PART 1. THE TITANIUM METAL INDUSTRY

This part considers the scope and competitive consequences of the Defense Production Act programs to expand domestic production and fabrication of metallic titanium.[1] It considers, in separate sections, the nature of the industry involved; the defense agencies which have been concerned in its expansion; the nature of the Government action which has encouraged the expansion of all phases of the titanium industry; and the competitive status of the industry which has emerged from the defense program. From these, conclusions are drawn as to the overall consequences of the various programs in evolving a competitive structure in this promising new industry.

I. THE NATURE OF THE TITANIUM INDUSTRY

The metallic titanium industry was selected for survey as an example of a relatively small industry vital to defense which received the full spectrum of Government expansion assistance. It consequently

[1] The titanium industry has two principal phases: The production of titanium pigments and production of titanium metal. This report concerns the development of the metallic titanium industry and the various Government aids and incentives used to encourage the expansion of this industry.

affords an opportunity to examine, within the limits of time and manpower available, the combined effects of various types of Government assistance on an entire industry.

Although titanium has long been known as a theoretically important metal, industrial realization of its unique advantages is still new. Technological difficulties, high costs, and defense needs have made normal commercial development virtually impossible. Industrial development of titanium has been substantially the result of Government assistance, and the types of Government assistance include nearly all those authorized under the Defense Production Act and related legislation.

To set the background for later discussion of the competitive problems in this industry as affected by the Government's action, we here describe briefly the nature of the metal, the organization of the industry concerned with it, and the overall scope of the Government assistance programs affecting this industry.

A. CHARACTERISTICS AND USES OF TITANIUM

Titanium is one of the most abundant elements, distributed widely in nature. It is estimated to be the fourth most plentiful of the structural metals. However, because of its intense chemical reactivity with other elements, pure metallic titanium does not exist in natural form, and its production even from high-content ores poses difficult technical problems.[2]

Of the many ore sources of titanium, only three are commercially important under present technology—rutile, ilmenite, and titanium slag. Rutile, containing a high proportion of titanium in oxidized form, is not found in economically significant quantities in the United States. Ilmenite, less rich in titanium, is found in varying concentrations in numerous places in this country. In the last 10 years, however, an important potential source of metallic titanium has been developed in the titanium-rich slag remaining after reduction of the iron content of certain titanium-bearing iron ores found in Quebec.[3] Despite transportation costs, imported rutile has been the principal raw material used to produce titanium.

Present technology for processing titanium ores for metal content derives principally from the Kroll process. This is a chemical extraction process, patented in the United States by a foreign national in 1940, and thereafter substantially modified first by Bureau of Mines experimentation and later in commercial adaptation.[4] It requires chemical treatment of batches of ore, with final reduction carried out in an inert atmosphere of argon or helium, producing a spongelike mass of metallic titanium. This titanium sponge must then be melted into ingot form, from which commercial shapes are fabricated.[5]

This metal possesses a strategic combination of useful properties. It is significantly lighter than steel, though heavier than aluminum, but possesses a tensile strength and hardness, when properly alloyed, which approaches that of high strength steel. The ratio of titanium

[2] Mineral Facts and Problems. Bureau of Mines Bulletin 556, U. S. Department of the Interior (1956), p. 907.
[3] Id., at pp. 905, 907, 910.
[4] The Kroll patent, which expires in June 1957, is available for licensing by the Attorney General through the Office of Alien Property, Department of Justice, as a result of vesting action by the United States Alien Property Custodian during World War II.
[5] Mineral Facts and Problems, supra, at p. 911.

strength to weight is considerably superior to aluminum or steel within certain temperature ranges (300°–800° F.), and it possesses unusual corrosion and fatigue resistance.

This combination of properties makes it highly suitable for many specialized applications, principally in aircraft and missile construction. Despite high cost and fabrication difficulties, the aerodynamic applications of titanium have greatly increased. As aircraft speeds increase, high temperature propulsion equipment and the crucial effect of aerodynamic heating on airframe strength require the high-temperature strength of titanium. At the same time, its relatively light weight adapts it to such use.[6]

B. THE INDUSTRY

Broadly considered, the titanium industry has four principal phases: (1) the mining of titanium-bearing ores, (2) the extractive metallurgical phase in which titanium sponge is produced, (3) melting of sponge into ingot, and (4) the processing or fabricating of the ingots into commercial shapes and forms.

The titanium industry is completely a development of the past 10 years. Prior to the Defense Production Act expansion, commercial development of the industry had barely started. It was not until 1946 that the du Pont Co. began formal research in this field. In 1948 it opened a pilot plant at Newport, Del., to continue research work and to produce small amounts of commercial titanium metal. The National Lead Co. also engaged in early research in this field, opening pilot plants in 1949 and 1951.[7] The United States Bureau of Mines had also been conducting studies on the properties of titanium and on processes to produce titanium metal. During 1950–51, its pilot plant at Boulder City, Nev., entered commercial-scale production under contract with National Lead. It was operated by the personnel of the latter to provide them with experience in titanium processes and techniques.[8]

During these early years, commercial production of titanium metal in various forms was minimal. Starting with 10 short tons in 1948, production had increased to only 75 short tons a year by the end of 1950.[9]

The Korean emergency, however, with its attendant industrial expansion, brought a number of other firms into the industry. For example, in 1950 Rem-Cru Titanium, Inc.[10] was formed to enter the melting and fabricating branch of the business. In the following year, Titanium Metals Corporation of America[11] was organized as a fully integrated firm, engaging both in the production of sponge, and in

[6] A 1953 survey of titanium requirements for airframe uses concluded that such purposes in the near future would require 3.5 pounds of pure titanium for each 100 pounds of airframe weight, with the total of titanium alloys reaching nearly 30 percent of airframe weight. Airframe Industry Titanium Usage Requirements—Summary Report, May 1, 1953, Aircraft Industries Association, prepared by Aircraft Research and Testing Committee, Washington, D. C.

[7] Mineral Facts and Problems, supra, pp. 920–921.

[8] National Lead Co. and du Pont began the manufacture of titanium pigments before the war. In a civil antitrust action brought by the United States, both were found to have participated in an international cartel restraining trade and commerce in titanium pigments and compounds through pooling of patents and allocation of markets, in violation of Section 1 of the Sherman Act. *United States* v. *National Lead Co., et al.*, 63 F. Supp. 513 (S. D. N. Y., 1945). While, on appeal, the judgment was sustained, the Supreme Court refused to order divestiture by these two companies, on the basis of the district court finding that "vigorous and effective" competition existed between the two, despite the cartel arrangement (332 U. S. 319, 351–353 (1947)).

[9] Titanium in 1956 (preliminary), Bureau of Mines, Mineral Market Reports Mms. No. 2587 (February 1, 1957), p. 2.

[10] Jointly owned by Remington Arms Co., a Du Pont subsidiary, and Crucible Steel Corp.

[11] Jointly owned by National Lead Co. and Allegheny Ludlum Steel Corp.

melting and fabricating. In 1951, also, Mallory-Sharon Titanium Corp.[12] was incorporated to melt titanium sponge into ingot and to produce mill products.

A number of other firms also entered the field in succeeding years. By 1956 there were five producers of titanium sponge in the field. They were Cramet, Inc.,[13] Dow Chemical Co., Electro Metallurgical Co.,[14] Du Pont and Titanium Metals Corporation of America (TMCA).[15] As a result, production of titanium sponge increased gradually from 495 short tons in 1951 to 7,000 in 1955, and then jumped to an estimated 14,100 short tons in 1956. The rise in production was accompanied by a gradual decrease in prices of titanium sponge, from over $5 per pound in 1948 down to $2.75 at the end of 1956.[16]

The melting and mill production branch of the industry had also grown. By 1956 the companies in this field included Harvey Machine Co., Mallory-Sharon, Rem-Cru, Republic Steel Corp., and TMCA. In addition, Oregon Metallurgical Corp., in mid-1956, began to produce to order small quantities of ingots and castings for other companies. Current expansion of facilities will raise the total domestic ingot capacity to well over the 37,500 tons expansion goal originally set by the Office of Defense Mobilization.[17]

C. GOVERNMENT EXPANSION PROGRAMS FOR TITANIUM

The Defense Production Act of 1950, as amended, was passed to provide authority to develop the productive capacity of the domestic economy to a level sufficient to meet existing demand and, beyond that, to provide a basis for full mobilization in event of a defense emergency. Titanium, however, was in an extremely rudimentary stage of development, and the expansion effort practically required the establishment of a whole new industry. To this end the various agencies concerned have utilized nearly all the expansion aids available. Those used include certificates of necessity permitting rapid tax amortization, grants for research and development, advances for expansion of plant capacity, and commitments to purchase output for the Defense Production Act Inventory and purchases for the national stockpile. The total nonrecoverable expenditures for these purposes rank the expansion of titanium as the fourth largest expansion program, with a probable cost estimated at 12 percent of the total of all programs administered under the Defense Production Act.[18]

1. Agencies administering the titanium program

Overall responsibility for the titanium expansion program rested in the Office of Defense Mobilization.[19] However, other Government agencies were delegated to handle various operational functions of the program.

[12] It was organized jointly by P. R. Mallory & Co., a processor of rare metals, and Sharon Steel Corp., one of the major steel companies in the field of specialty steel products.

[13] Organized in 1953 as a subsidiary of Crane Co., which is primarily a piping, valve, and fitting company. However, in 1956, Republic Steel Corp. purchased a ½ interest in the firm.

[14] A division of Union Carbide & Carbon Corp.

[15] In addition, 2 other companies—U. S. Industrial Chemicals Co. (a division of National Distillers Products Corp.) and a firm to be organized jointly by Kennecott Copper Corp. and Allied Chemical and Dye Corp.—will build plants to enter production of titanium sponge. With these new entrants, plus announced expansion of existing facilities, it is expected that by 1958 sponge production will reach a total capacity of 36,500 tons. Titanium in 1956 (Preliminary), supra, pp. 2–3.

[16] Titanium in Industry (Preliminary), supra, pp. 2, 6. See also, table 3, appendix.

[17] Ibid. See table 4, appendix.

[18] Report on Borrowing Authority, December 31, 1956, Office of Defense Mobilization, p. 9.

[19] Reorganization Plan No. 3, sec. 2 (b), effective June 12, 1953, 67 Stat. 634; Executive Order No. 10480 of August 14, 1953, 18 F. R. 4939.

First of all, the Department of Defense was responsible for furnishing the military requirements for titanium to ODM as a basis for determining the necessity and extent of required expansion of productive facilities.[20] In addition, since most of the present uses of the metal are in military items, it sponsors research and development contracts on titanium which independently supplement the overall DPA program.[21]

Responsibility for recommending expansion goals for titanium sponge facilities rested with the General Services Administration prior to 1954.[22] This agency also reviewed requests for accelerated tax amortization certificates and submitted recommendations for ODM.[23]

Once the expansion goal was established, GSA was empowered to enter purchase contracts with producers or potential producers for the DPA inventory to encourage expansion of existing facilities or the construction of new ones. Where appropriate, it also offered advances on such contracts in order to assist such construction. In addition, GSA was also in charge of purchase and storage of titanium or its concentrates held in the strategic and critical materials stockpile.[24]

With respect to titanium melting or fabricating facilities, no expansion aids were utilized other than accelerated tax amortization. In this field, the Business and Defense Service Administration of the Department of Commerce had responsibility for recommendations concerning both expansion goals and grants for rapid tax amortization certificates.[25]

Rutile is the principal ore used in the production of titanium sponge. As such, it was included among the exploration projects undertaken to develop domestic sources of strategic and critical metals or minerals under the DPA. The Defense Minerals Exploration Administration of the Department of Interior is in charge of this program.[26] It enters into contracts with private parties for the exploration of undeveloped sources of such metals or minerals, contributing a stated percentage of the costs in return for certain royalty rights to the fruits of discoveries made. In the case of rutile exploration, Government participation was fixed at the rate of 75 percent of the costs.

Advisory functions in aid of the titanium program have been performed by the Titanium Advisory Committee in the Office of Defense Mobilization; the Materials Advisory Board in the National Academy of Sciences, National Research Council; the Steering Group on Titanium Research and Development in the Office of the Secretary of Defense; and the Titanium Producers and Fabricators Industry

[20] Executive Order No. 10480, 18 F. R. 4939; BDSA Delegation 1.

[21] The Department of Defense has about 125 active contracts amounting to about $10 million. A little over one-third of the total is devoted to physical metallurgy—mainly work on alloy development and transformation. Approximately one-third is devoted to processing—the major portion on welding and joining, with smaller amounts on heat treatment, finishing and coating. The remainder of the research funds was devoted principally to determination of design data.

[22] This function has now been transferred to the Office of Minerals Mobilization, Department of Interior, Executive Order No. 10480, 18 F. R. 4939; DMO I-7, as amended, 18 F. R. 5366, 19 F. R. 7348; DMO VII-5, as amended, 18 F. R. 6408; 19 F. R. 7349; DMO I-13, 19 F. R. 7348.

[23] See Interior Delegation 1.

[24] Executive Order No. 10480, 18 F. R. 4939; DMO I-7, as amended, 18 F. R. 5366, 19 F. R. 7348.

[25] Executive Order No. 10480, 18 F. R. 4939; DMO I-7, as amended, 18 F. R. 6736, 18 F. R. 6737; DMO I-8, 19 F. R. 875; DMO VII-5, 18 F. R. 6408; Commerce Order No. 152, as amended, 18 F. R. 6503, 18 F. R. 6791, 20 F. R. 6263.

[26] Executive Order No. 10480 of August 14, 1953, 18 F. R. 4939, as amended by Executive Order No. 10662 of March 13, 1956, 21 F. R. 1673; DMO I-7, as amended, 18 F. R. 5366, 6737; 19 F. R. 7348; Interior Orders 2726, 18 F. R. 3804; 2755, 19 F. R. 2503; 2764, 19 F. R. 4005; and 2781, 20 F. R. 316.

Advisory Committee of the Business and Defense Services Administration.

2. Expansion goals set for titanium

As noted, titanium production in 1950 consisted of a total of 75 short tons; and melting and fabrication facilities were only experimental.[27] At present, the industry is close to a capacity of 30,000 short tons of sponge, with melting capacity of approximately the same amount, and fabrication facilities reaching the goal of 37,500 short tons.[28] This expansion was not the result of a single, planned surge toward present goals. Rather, it is the culmination of a series of goals established for the various phases of the industry.

Logically, the first such expansion goals were set for the production of sponge. In March 1951, an initial goal of 7,200 tons was established.[29] Little more than a year later, in June 1952, a second goal was set, calling for an additional 2,800 tons capacity, to a total of 10,000 short tons capacity to be achieved by 1955.[30] The third goal, established in October 1952, more than doubled the previous objective, calling for 22,000 tons production capacity to be reached by 1955.[30] On the fourth round of expansion, under the goals set in August 1953, the industry was to achieve a plant capacity of 25,000 tons by 1956.[30] In 1954, ODM informally authorized GSA to negotiate toward a total sponge capacity of 35,000 tons per year. Later, however, it was reported that technical difficulties in fabrication limited consumption to about one-third of production. A review by ODM's consulting staff concluded that a similar disparity would continue for a few years.[31] Accordingly, it was decided in September 1955, to reduce the sponge goal to the 22,500 tons represented by expansion already contracted for. The sponge goal was accordingly suspended.

Expansion of melting facilities followed as planned sponge capacity came into being. An expansion goal for ingot capacity was set in February 1954, calling for an increase of the existing 7,680 tons of melting capacity to a total of 37,500 tons.[32] This goal was closed on December 28, 1956.[33] Similarly, in August 1954, the expansion goal for processing ingots to mill products was set at 37,500 tons and was closed as achieved on December 28, 1956.[34]

3. Expansion incentives employed

The expansion programs in the titanium field have been characterized by the utilization of a variety of types of Government assistance and incentives. These have included—

(*a*) *Advances and commitments to purchase output.*—Use of Government funds for financing of capital costs of fixed investment in plant facilities through advance payments on contracts giving the contractor an option to require the Government to purchase certain quantities of output at stipulated prices.

(*b*) *Accelerated tax amortization.*—The Revenue Act of 1950 permits the portion of the cost of a facility, required for defense

[27] Supra, p. 7.
[28] Titanium in 1956 (Preliminary), supra, p. 3. See also tables 4 and 5, appendix.
[29] Mineral Facts and Problems, supra, p. 922.
[30] Ibid.
[31] This review was conducted by Harold S. Vance, chairman of the board of Studebaker-Packard Corp., as consultant to ODM. The Vance report rested on consideration of national defense not directly relevant to the competitive problems which this report considers.
[32] Titanium in 1956 (Preliminary), supra, p. 3.
[33] DMO VII–6, December 28, 1956, 22 F. R. 11.
[34] Ibid.

purposes, after allowing for post-emergency utility and other factors, to be written off for tax purposes over 5 years instead of the longer depreciation period based on the estimated economic life of the facility.

(c) *Grants for research and development.*—Negotiation of contracts providing Government funds to underwrite the cost of developing technologically feasible and commercially practicable production methods.

(d) *Revolving inventory funds.*—Financing purchases in excess of industry requirements for temporary revolving stockpile to maintain capacity production during development of military application and solution of problems encountered in fabricating titanium ingots into useful commercial forms.

There have been other forms of Government assistance to the titanium industry administered in aid of the Defense Production Act. These include much of the work done by the Bureau of Mines and research and development contracts administered by the Department of Defense with appropriated funds.[35]

4. Expenditures for titanium expansion

The October 1952 certification of an expansion program to 22,000 tons annual capacity authorized GSA to borrow $128,700,000 from the Treasury of the United States under authority contained in section 304 of the Defense Production Act.[36] This sum, of which $25 million was earmarked for process development, constituted a fund from which advances and purchase commitments could be met, to be replenished by the proceeds of sales and repayments. However, a ceiling of $895 million in gross transactions was established as an overall limitation on use of this capital fund.

The latest Report on Borrowing Authority, submitted to Congress pursuant to section 304 (b) of the Defense Production Act reports that, of the total of $895 million gross transactions authorized, transactions actually consummated amount to $215,096,000.[37]

This may be broken down according to transactions completed and outstanding and the probable ultimate net cost to the Government, as follows:

	Consummated contracts	*Probable ultimate net cost*
Completed	$98, 670, 000	$43, 895, 000
Outstanding	116, 426, 000	60, 769, 000
Total	215, 096, 000	104, 664, 000

Of the total of $128,700,000 borrowing authority allocated to GSA, $24,036,000 remains uncommitted.

Some insight into the importance of the titanium program in relation to all defense expansion programs may be obtained from the fact that the $215,096,000 of consummated transactions represents 2.79 percent of the dollar value of all transactions carried out with borrowing authority funds made available pursuant to section 304 of the Defense Production Act. Moreover, the estimated nonrecoverable cost of the

[35] Examination of these contracts discloses no such variance from the pattern of defense research and development contracts generally as to justify separate statement of any conclusions substantially different from those applicable to the general problem. The competitive problems in Government research and development contracts generally were discussed at length in the Report of the Attorney General Under the Defense Production Act, dated November 9, 1950.

[36] Program certificate DMPA-126-11-DPA-199, October 16, 1952.

[37] Report on Borrowing Authority, supra, p. 10.

titanium program to date, amounting to $104,664,000, represents 12.29 percent of the estimated nonrecoverable cost of all programs.[38] It is exceeded in dollar amount only by the programs for tungsten, nickel, and manganese. These 4 mineral programs together account for approximately 60 percent of estimated loss in consummated gross transactions.

II. Administration of Titanium Expansion Programs

Against this general background, consideration is given to the specific expansion programs in each of the stages of the industry—ore supply, including exploration, mining, and beneficiation;[39] sponge production; and melting and fabrication. This section details the various incentives used in relation to each level of the industry.

A. ORE SUPPLY

Securing adequate supplies of suitable ore is the first step to insure a strong titanium industry. Up to the present, the titanium-rich rutile ores imported from Australia have been a principal source for titanium dioxide and metallic titanium.[40] Development of an adequate mobilization base, as well as an expanding domestic industry, necessarily requires provision for the utilization of domestic supplies in lieu of oceanborne imports. Such utilization, however, requires development of processes for upgrading the leaner domestic ores available to suitable quality for use with the modified Kroll processes; or the development of extractive processes adapted to the domestic supply.[41] At the same time, it is necessary to provide an adequate stockpile of ore to meet emergencies which would interrupt the rutile imports.

The titanium expansion programs have made provision to meet these needs through exploration and research contracts, stockpile and defense inventory purchases, and the grant of rapid tax amortization certificates. In addition, the 1954 addition of ilmenite to the internal revenue list of minerals for which depletion allowances are available[42] has given assistance to the expansion programs. These types of assistance are considered with an eye toward ascertainment of competitive consequences.

1. Exploration and research contracts

This program has involved an outlay of only $26,675. From its inception in 1952, the Defense Minerals Exploration program included rutile and brookite as eligible for exploration assistance. For these, the contribution by the Government was set at 75 percent of the cost of approved projects. Under this program, 11 applications have been received by the Defense Minerals Exploration Administration,[43] of which 1 was granted and 2 are pending. Two of the remaining applications were withdrawn, and six were denied.

[38] Id., p. 9.
[39] Beneficiation is the process of concentrating or otherwise preparing ore for smelting.
[40] Mineral Facts and Problems, supra, p. 905.
[41] Id., at pp. 905-906.
[42] Internal Revenue Code of 1954, sec. 613 (b).
[43] The minerals exploration regulations (D. M. E. A. Order No. 1, as amended, 19 F. R. 1563, 20 F. R. 337, 1698, and 21 F. R. 3839) specify the following factors to be considered in processing of applications: (*a*) Strategic importance of the mineral; (*b*) the geologic probability of significant discovery; (*c*) the availability of manpower, materials, supplies, equipment, water and power; (*d*) accessibility of the project; and (*e*) the operating experience and background of the applicant.

The approved application was that of National Lead Co., for exploration costs of approximately $20,900 with respect to examination of Florida sands as a rutile source. The Government participation amounted to $15,675 of the total, repayable from a 5 percent mineral royalty on ore produced from the project during the period ending May 1962.

The remaining applications were identified as those of small business concerns, including prospectors, partnerships and small corporations. Six of these were denied, although information was not made available as to the identity of the applicants, or the reasons for denial.

With respect to mineral research, one small contract for research on the commercial utilization of brookite was granted. National Lead Co. was awarded $11,000 to mine 50 tons of ore from deposits at Magnet Cove, Ark., and to determine its feasibility for use in welding-rod coatings and as a source of titanium metals.[44]

2. Stockpile and defense inventory purchases

Purchase of titanium-bearing ores for national stockpile or for the defense materials inventory have not figured significantly in the development of an ore supply. There were no purchases for DPA inventory; stockpile purchases were limited to rutile ores.

Rutile was first placed on the strategic and critical materials list for stockpiling on November 20, 1944,[45] under a classification providing for its acquisition either by purchases or by transfers from Government-owned surpluses. In July 1950, rutile was transferred to a classification under which materials may be acquired only from Government surplus, and no procurement has been undertaken since that time. A total of $2,070,134 of rutile was acquired prior to that date, and remains in the stockpile. In 1952, to relieve an immediate shortage, a withdrawal of 1,000 pounds was authorized.[46] Removal of the OPS price ceiling on rutile in 1952 permitted domestic purchasers to compete more effectively in the world market, and no shortages have since existed.[47]

3. Tax amortization certificates [48]

From 1951 to the present, four certificates of necessity were issued by the Office of Defense Mobilization authorizing accelerated tax amortization benefits in connection with titanium ore mining projects. A total of $1,606,000 was certified, of which 65 percent was eligible for rapid tax amortization.[49] All of the operations involved rutile mining operations in Florida.

Three of the certificates, covering a total of $464,000, were issued to two small independent ore-processing companies. One of these companies (Florida Ore Processing Corp.) has since ceased operations, and its operations reportedly were taken over by the other small company. Most of the certified amount, however, related to the rutile mining operations of Marine Minerals, Inc., a subsidiary of Heavy Minerals, Inc., a corporation owned jointly by the Crane Co.

[44] Mineral Facts and Problems, supra, p. 908.
[45] Id., p. 915. Rutile was stockpiled primarily for welding-rod coatings.
[46] Id., p. 909.
[47] Ibid.
[48] As discussed in my February 9, 1956, report under the Defense Production Act, determination of the exact amount of subsidization concerned in these grants is impossible. Each grant represents a benefit to the recipient which varies in relation to the recipient's tax status and the changes in tax laws. In general, however, the privilege of accelerated tax amortization amounts to an interest-free loan of an amount equal to the tax liability which is deferred until later years, and therefore must be treated as a subsidy to that amount.
[49] See table 1, appendix.

and others. The Crane Co., through another subsidiary, Cramet, Inc.,[50] is one of the principal titanium-sponge producers.

B. SPONGE PRODUCTION

Existing methods for titanium extraction based on the Kroll process produce metallic titanium in sponge form. These processes are recognized as inefficient, and their high cost is a deterrent to a more widespread use of titanium in military and civilian applications. Consequently, DPA assistance to this branch of the industry proceeded along two major lines: research and development to improve production methods, and the expansion of sponge production capacity by means of purchase commitment contracts, stockpile acquisitions, and tax amortization certificates.

1. Research and development

General Services Administration supervises the research and development program designed to achieve a technological breakthrough in sponge processes. Technical assistance is provided GSA by the United States Bureau of Mines and the Materials Advisory Board of the National Academy of Sciences. The Academy has conducted studies, surveys, and analyses of problems in the treatment and metallurgy of metals and minerals. It has also undertaken technical reviews of research projects proposed to GSA by industry. Once such research projects have received GSA awards, Bureau of Mines representatives have conducted periodic field inspections of contract facilities to check on performance under the contracts.

The Bureau of Mines also conducts research projects on titanium-sponge production. Investigations of modifications of the Kroll process are conducted on a pilot plant scale in its laboratory at Boulder City, Nev. A description of the pilot plant equipment, techniques of operation, method of sponge recovery, operation data, and power and labor requirements was the subject of a Bureau of Mines report in 1952.[51]

In 1955, it entered into a contract with GSA to do research work on the development of a process for production of titanium tetrachloride from more abundant domestic titaniferous raw materials.[52] This contract is presently being performed at the Bureau's station at Albany, Oreg., and the Boulder City, Nev., laboratory.

GSA has also awarded three research contracts to private industry: On July 1, 1954, Horizons Titanium Corp. received a contract providing for the design, installation, and operation of a pilot plant to study a new electrolytic process for producing titanium sponge.[53] The total cost to the Government was not to exceed $564,300. The contract provided for repayment if commercial production was undertaken by the contractor within ten years from the date of his final report under the agreement. In addition, the Government was to

[50] See infra, p. 28.

[51] Cook and Wartman. Removal of Magnesium and Magnesium Chloride from Titanium Sponge by Vacuum Distillation. Bureau of Mines Report of Investigations 4837 (1952). The Bureau of Mines has also published other reports of investigations which solved or clarified problems involved in production and fabrication. See, generally, U. S. Department of Commerce, Report CTR 306, September 1954, 26 pp., a bibliography which lists all Government titanium-research reports made available to industry. The research reported covers all characteristics of the metal, including its physical, chemical, and electrical properties.

[52] Contract No. DMP-116, September 30, 1955.

[53] GSA Contract No. DMP-101. Horizons Titanium Corp. is a joint venture subsidiary of Horizons, Inc., and Ferro Corp.

receive nonexclusive royalty-free licenses to any patents resulting from the project.

In the following year, GSA entered a research contract with Horizons, Inc.[54] It involved the design, construction, and operation of a pilot plant, with a capacity of 5 to 10 pounds per day, which would utilize an electrolytic process to recover titanium sponge from alloyed and unalloyed titanium scrap. The company received no fee; the Government was to pay for the costs, which were not to exceed $134,740. This contract also contained provisions for reimbursement of costs and nonexclusive royalty-free licenses on patents if commercial production should result from the study.

Both of these contracts have been completed, and the results analyzed by GSA. From the limited information made available, it appears that some patents but no commercial production will result from the two studies. It is reported that both projects contributed valuable information on the subject, but neither was entirely successful in pointing the way to more efficient and satisfactory production processes.

The most recent research contract was that with National Research Corp. in 1955.[55] Under this contract, National Research Corp., in association with Monsanto Chemical Co., was to construct and operate a pilot plant of 1,000-pounds-per-day capacity for the production of titanium metal from purified titanium tetrachloride and commercially available sodium by means of a fused salt process. The work was estimated to cost about $1,183,495. The Government was to reimburse the firms for costs, but the contractor received no fee. Nonexclusive royalty-free licenses on the patents which may be developed were to be issued to the Government. The contract also contains provision for repayment of the Government's investment should the process result in commercial production within 10 years. This contract has since been extended to June 30, 1957, at no extra cost to the Government.[56]

2. Advances and commitments to purchase output

The Government assisted the expansion of sponge production by advancing capital costs of fixed investment in plant capacity, as part of a contract to purchase a portion of the plant output at specified prices. The amount not repaid by deliveries to the Government under the purchase contract was to be amortized by repayment at a specified amount per pound from production at the plant after it became operational. These advance payments were in essence construction loans.

During the life of the expansion program, GSA considered a total of 11 proposals for purchase-commitment contracts. Contracts were actually entered with 5 companies, resulting in additional annual capacity of about 21,000 tons. Proposals involving 6 other companies, which would have created an additional 23,000 tons capacity, were eventually discarded by GSA.

The first such contract was a letter contract of August 1, 1951, with the newly created Titanium Metals Corporation of America for

[54] GSA Contract No. DMP–114, dated April 29, 1955.
[55] GSA Contract No. DMP–113, dated May 17, 1955.
[56] One additional contract was undertaken which indirectly assisted the research program. Western Pyromet Co. was seeking facilities to undertake an independent research project on titanium-sponge production. Accordingly, GSA granted that firm rights to use the Government-owned magnesium plant at Manteca, Calif., for experimental and pilot operations for a period of 9 to 12 months. The Government under the contract received payments of $2,000 per month for the duration of the project.

the construction and operation of a plant at Henderson, Nev. The contract called for annual capacity of 3,600 short tons. Commencing with the date when the plant was capable of producing approximately 1,800 tons of titanium a year, the Government had the right to call for up to 100 tons of titanium sponge or ingot during each calendar quarter for a period of 10 years. The purchase price was set at the lower of $5 per pound or the market price at the time of delivery.

Under the terms of the contract, an advance payment of $15 million was made to TMCA. Interest at 4 percent per year on the unpaid balance was charged on the advance. If total deliveries of the metal should be less than the equivalent of the advance, the unpaid balance was to be repaid to the Government in cash.

By the end of 1956, the Government had purchased 753 tons from TMCA at an average of $8,210 per ton. In addition, interest payments of approximately $2,379,000 have also been received. Considering all factors, GSA estimates that as of December 1956 the probable ultimate net costs of the contract to the Government is $791,000.[57]

E. I. du Pont de Nemours Co., Inc., executed the second agreement on July 24, 1952. The Government agreed to advance up to $14.7 million to expand the company's titanium-producing facilities at Newport and Edge Moor, Del. The loan was to be repaid at 4 percent interest as salable titanium sponge was produced. The full value of all deliveries to the Government was to be credited against the advance. The contract called for the average annual production of 2,700 short tons, in addition to the company's existing annual output of 900 tons. For 10 years after the date when the additional facilities were capable of producing approximately 1,350 tons of titanium annually—or until the advance was repaid—the Government could call for up to 75 tons of such titanium sponge produced from the additional facilities during any calendar quarter. Conversely, while any part of the advance remained unpaid, Du Pont could require the Government to accept tenders during any quarter of up to 675 tons in the event this production could not be sold to industry. The price per pound to the Government was the lower of $5 per pound or market price at the time of delivery.

Under this contract, the Government advanced an actual total of $10,340,000. This advance has now been completely repaid by payment of $9,061,000 in cash and by the delivery of 150 tons of titanium valued at $1,279,000. The Government also has purchased an additional 29 short tons at $240,000. The probable ultimate net cost to the Government is currently estimated at a profit of $34,000.[58]

On July 31, 1953, Cramet, Inc., signed a contract for the construction and operation of a plant at Chattanooga, Tenn., with capacity of 6,000 short tons of titanium sponge annually. The Government agreed to advance up to $24,950,000 for construction and equipment costs, to be repaid with interest at 5 percent on the unpaid balance from the date of the advance. The Government received an option to purchase up to 7,500 tons of titanium sponge during the term of the contract (*a*) at $5 per pound for any sponge bought during the first year of production, and (*b*) thereafter, at $4 per pound or market price, whichever was greater. On the other hand, the company could

[57] Report on Borrowing Authority, supra, p. 38.
[58] Report on Borrowing Authority, supra, p. 38.

require that the Government buy up to 6,000 tons of sponge during the life of the contract at $5 per pound during the first year of production (not to exceed 1,000 tons) and $4 per pound thereafter. The contract termination date is January 31, 1961.

The Government actually advanced the full total of $24,950,000 on this contract. In return it has acquired a total of 600 tons of sponge at $10,000 per ton, and 5,400 tons at $8,000 per ton. The current estimate of probable ultimate net cost to the Government on this contract is $31,460,000.[59]

The last two expansion contracts were awarded by GSA in 1954. A contract was entered with Dow Chemical Co. on July 8, 1954, providing for expansion of its existing facilities at Midland, Mich., from 600 pounds per day to 5 tons per day by July 1956. The total annual capacity was to be 1,800 tons. However, no advance payments were provided under the contract, the company agreeing to expand at its own expense, provided it was assured a market for titanium sponge. The Government agreed to buy the sum of 2 million pounds of titanium sponge produced by the company before July 1956 if the company was unable to find other markets or if the Government exercised its option right. It was to be purchased at market price for the first 6,030 pounds in any month; the balance was to be sold at $5 per pound or the lowest offer quoted to any other customer. The company agreed to maintain the rated capacity of 5 tons per day for a period of 5 years, and in case of a plant shutdown, to reactivate the facility fully within 120 days.

Through 1956 the Government has acquired 1,000 tons of sponge under this contract, at a total cost of almost $10 million. On the basis of resale at an average of $4,000 per ton, it is estimated that the probable ultimate net cost to the Government to date is $5,774,000.[59]

The final purchase commitment contract was negotiated by GSA with Electro Metallurgical Co., dated September 10, 1954. It called for construction of a $31.5 million plant at Ashtabula, Ohio, to produce 7,500 short tons of titanium annually. The agreement stated that the company would use its own funds for the design, construction, and equipment of the facility. The company had the right to deliver to the Government whatever production it was unable to sell in the commercial market, up to a maximum of 7,500 tons annually. On the other hand, the Government had an option to buy 4,500 tons annually at the market price prevailing at the time of delivery. The contract was scheduled to run until 1961. However, it contained a provision for cancellation of the Government's purchase commitment on 12 months' notice. This provision was exercised in the early part of 1957.

The Government will acquire an estimated total of 9,417 short tons under this contract. As of December 1956, the probable ultimate net cost of the contract is believed to be about $37,626,000.[60]

The Director of ODM, on September 12, 1955, announced the suspension of any further Government aid for the creation of additional titanium sponge capacity. Its expansion goal was officially closed on September 29, 1955.[61]

However, prior to these actions, GSA had been negotiating with a number of other companies on proposed purchase commitment con-

[59] Ibid.
[60] Id., at p. 37.
[61] DMO VII-6, September 29, 1955, 20 F. R. 7370. The development of titanium sponge capacity under the DPA, as well as subsequent planned expansion, is found in table 5, appendix.

tracts which would add additional sponge capacity to the industry. These firms, together with their contemplated new sponge capacities, were: Harvey Machine Co., already a titanium-ingot producer, 4,000 tons; Titanium Metals Corp., 5,400 tons; Western Pyromet Co., 6,000 tons; Kennecott Copper Co., 1,000 tons; Wah Chang Corp., 6,000 tons; and Aero Metals, 1,000 tons.[62] Subsequently, Columbia-Southern Chemical Corp. submitted a proposal for 5,000 tons. These negotiations were ultimately terminated by GSA as the result of the closing of the expansion goal.[63]

3. Stockpile acquisitions

The national stockpiling effort has touched upon the titanium-sponge industry expansion only with respect to the operations of the DPA inventory.[64] Materials acquired under the expansion program are held in that inventory for later resale to industry.

In the course of the titanium-sponge expansion program demand for the metal was not always sufficient to absorb all production, even with the Government purchase commitments. Unless cutback of sponge production was to occur, acquisitions for DPA inventory beyond existing purchase commitments were necessary. Accordingly, early in the expansion program the Defense Production Administration authorized, on August 30, 1951, the establishment of a temporary revolving-fund inventory program to operate in conjunction with the purchase-commitment program. A sum of $5 million was provided for the purchase and later resale to industry of not more than 500 tons of sponge.[65]

Only one contract was entered into under this program. It was negotiated by GSA with du Pont in October 1951, to acquire surplus production from that company's original Newport, Del., plant. Although ultimately continuing in force until December 31, 1953, the increasing industry demand in 1953 obviated the necessity for any inventory purchases under the contract after the beginning of that year. Total purchases from du Pont under the contract amounted to 303 tons. By June 22, 1953, all of this material in the inventory had been sold to fabricators of military equipment at no loss to the revolving fund other than $7,000 for handling expenses.[66]

Early in 1954, there occurred a sharp slump in demand for titanium metal in aircraft components and parts. To prevent severe cutbacks in production, ODM authorized the establishment of a titanium sponge working inventory of 4,000 tons.[67] Shortly thereafter, by June 1954, GSA negotiated working inventory contracts with both du Pont and TMCA.[68] The du Pont contract required that GSA purchase current production until September 30, 1955, up to a maximum of 3,050 tons, which could not be absorbed either by industry or under the terms of the Government's purchase commitment expansion contract. Under the TMCA contract, GSA was obligated to purchase up to

[62] Titanium, report of Subcommittee on National Stockpile and Naval Petroleum Reserves of the Armed Services Committee, U. S. Senate, 84th Cong., 1st sess. (May 25, 1955), Committee Print, p. 4.
[63] In addition, a proposal for expansion of du Pont capacity to about 7,200 tons had been withdrawn prior to suspension of the goal.
[64] Although titanium sponge was included, on July 16, 1954, in the list of group I materials for acquisition in the strategic and critical materials stockpile, and specifications for it were promulgated on September 21, 1956, no titanium sponge has as yet been purchased for that stockpile since funds have not as yet been made available.
[65] Mineral Facts and Problems, supra, p. 924.
[66] Id., at pp. 924–925.
[67] ODM Press Release No. 304, April 29, 1954. This working inventory was raised to 8,000 tons on March 7, 1955.
[68] Purchase Contract No. DMP-95, April 2, 1954; Purchase Contract No. DMP-96, April 8, 1954.

2,963 tons before the same termination date. During the life of these contracts, the Government purchased a total of 2,642 tons of inventory sponge from du Pont and 2,682 tons from TMCA.[69]

In 1955, two small working inventory contracts were negotiated by GSA. One was with Cramet, Inc.,[70] whose new plant at Chattanooga, Tenn., created pursuant to Government purchase commitment contract,[71] was nearing completion early in 1955. Under this new inventory contract, GSA purchased a total of 24 tons of sponge produced in trial runs before the plant became commercially operational.[72] The other working inventory contract was entered with Wah Chang Corp. on July 19, 1955.[73] That firm had obtained the use of the Bureau of Mines Boulder City, Nev., plant to conduct experimental production on an improved sponge-production process. GSA purchased under this contract a total of 69 tons from that production run.[74]

4. Tax amortization certificates

As noted,[75] tax amortization certificates were granted in titanium sponge expansion in conjunction with the negotiation of purchase commitment contracts. All the firms receiving expansion contracts, except Dow Chemical Co., filed applications for rapid tax amortization covering the expanded facilities. These applications were all approved, granting 90 percent certification on facilities with a total cost of $81,435,640.

There were 9 applications for tax amortization on sponge production facilities, of which 6 were approved.[76] TMCA received one on facilities, costing $14 million. Cramet, Inc., was approved for its plant costing almost $25 million, and Electro Metallurgical Co. obtained a certificate on its $31.5 million plant. Du Pont received 3 certificates for facilities valued at $1 million, $9.5 million, and $40 million, respectively. However, the last application, approved in March 1955, was subsequently canceled at du Pont's request in September of the same year.[77]

Two applications were filed—by National Distillers Products Corp. and Columbia Titanium Co.—shortly before the titanium sponge-expansion goal was closed in September 1955. They were subsequently disapproved as in excess of the goal. A third application, covering $25 million in facilities, had been received from Harvey Machine Co. in March of 1954. ODM's action was deferred, however, pending protracted negotiations by GSA with the company over a purchase commitment expansion contract and construction advances. After the expansion goal was closed in September 1955, this application and the expansion contract were dropped.

C. MELTING AND FABRICATING

Because of the characteristics of titanium metal as it emerges from the extractive process in sponge form, special facilities are required

[69] Report on Borrowing Authority, supra, p. 38.
[70] Purchase Contract No. DMP-109, April 6, 1955.
[71] Supra, p. 28.
[72] Report on Borrowing Authority, supra, p. 39.
[73] Purchase Contract No. DMP-115, July 19, 1955.
[74] Report on Borrowing Authority, supra, p. 38.
[75] Supra, p. 22.
[76] See table 1, appendix.
[77] Under existing regulations, certificates of necessity expire unless construction of the certified facilities begins within 6 months from their approval. The 6-month period for this $40 million certificate would have expired within a few days of du Pont's cancellation action.

for its further processing before it can be utilized. Thus, the sponge must be melted into ingot shape, requiring a substantial amount of special facilities not useful for other purposes. Similarly, the peculiarities of the metal require fabricating facilities to handle the ingot production. Of these, the melting capacity is most specially limited to titanium handling, for much of the equipment available for the fabrication of stainless steels can be adapted to titanium.

Once the crucial sponge production capacity expanded, increase of melting and fabrication capacity followed almost as a matter of course. For the entire expansion of these facilities, the only direct incentive utilized was the grant of accelerated tax-amortization privileges.[78] The amounts certified for tax aid of this nature were substantial, involving a total of $57,645,961 in titanium melting and fabricating facilities. The percentage of the certified facilities eligible for rapid tax amortization varied between 65 and 90 percent.

Of this total, $25,609,077 represented certifications for melting facilities. Four groups of affiliated companies shared this total:

Du Pont group [1]	$6, 014, 033
TMCA [2]	5, 287, 930
Cramet [3]	10, 130, 000
Mallory-Sharon [4]	4, 177, 114

[1] E. I. du Pont de Nemours & Co., Inc., and Rem-Cru Titanium Co.
[2] Titanium Metals Corporation of America, National Lead Co., and Allegheny Ludlum Corp.
[3] Crane Co. and Republic Steel Co.
[4] P. R. Mallory Co. and Sharon Steel Co.

The grants for fabricating facilities were somewhat more widely distributed. The four company groups listed above, however, received about 84.6 percent of the total of $32,036,884.[79] The remainder were scattered among four other companies which have no affiliations or operations at other levels of the industry.[80]

III. The Competitive Status of the Expanded Industry

We now turn to consideration of the whole of the industry as it has emerged from the defense expansion efforts of the past 6 years. Under the statute, our concern is with the competitive effects of the defense production effort and its impact on small business.[81] And substantially all this industry, in all its phases, is the result of the direct and indirect subsidization flowing from the defense need for this metal.

The industry has not yet assumed a fully commercial status, for practically all of its output is still destined for defense purposes.[82] There has as yet developed no real civilian market, and defense-rated allocations rather than competition in sale is the rule. Until there is a diversification into civilian uses, there probably will be little opportunity for small business at any level. Indeed, on the basis of the investments required, the basic production level appears to be completely unsuitable for small business participation.

In the main, the relatively large number of companies of substantial size and strength in each level is somewhat unusual for a

[78] See table 1, appendix.
[79] See table 2, appendix.
[80] See table 1, appendix.
[81] 50 U. S. C. App. 2158 (e), Supp. III, 1956.
[82] BDSA states that 98 percent of titanium products are used at present for military purposes, although existing allocation regulations only purport to require 90 percent for defense-rated orders. BDSA Order M–107, May 19, 1954.

newly developed industry. Some tendency toward vertical integration under common ownership is displayed. The industry, at each level, is dominated by related concerns whose affiliations conceivably might provide the basis from which fully integrated single concerns will emerge. However, this tendency is not yet a dominant one.

Thus, while the commercial development of this industry may not be foretold, it appears that the defense production effort has exerted a considerable influence in shaping it toward a fully competitive status.

This section first considers the limited participation by small business in the titanium industry and then turns to consideration of the unusual number of joint ventures which characterize it.

A. SMALL BUSINESS PARTICIPATION

It is clear that small-business participation has been extremely limited. However, a number of practical factors have weighed heavily against a more significant small-business role in the principal levels of this industry.

Thus, there are very heavy fixed capital investments in plant facilities required under existing technology. Large amounts of working capital are dictated by high unit cost. Even more significantly, there is a high risk that production or processing facilities built around the costly and technologically unsatisfactory processes presently in use may quickly become obsolete. Finally, there is the uncertainty of civilian demand for titanium, with a long period of civilian product experimentation required before any reliable prediction of future demand may be made.

Beyond these practical business factors, there are other deterrents stemming from the urgency of the present defense need for this metal. Only the larger companies had in being technical staffs of sufficient size and experience to offer reasonable prospects of quick success in solving the immediate technical problems hindering defense availability of this metal. As a tactic of necessity, decision was made to rely on those prospective producers most likely to attain maximum production in minimum time.

At the same time, there appear to be neglected possibilities for small-business participation in some of the industry's levels. Such a lost opportunity may well be represented by the disapproval of all small-business applications for exploration grants.[83] In view of the relatively limited amount of activity under this heading, too much importance can easily be attached to the denial of applications. Moreover, as noted,[84] no information was made available upon which to weigh the disposition of these proposals. Nevertheless, the sole instance of exploration grant was to one of the larger of the integrated company groups; and all of the reportedly small-business applications disposed of to date were denied on the recommendation of the Defense Minerals Exploration Administration.

Another opportunity may have been lost in the denial of the tax-amortization application of the Harvey Machine Co. for aid in entry into sponge production.[85] True, as already noted, there are substantial practical factors militating against survival of the smaller company in the high-investment, high-cost, and high-risk production level. It

[83] *Supra*, pp. 19-20.
[84] *Ibid.*
[85] Supra, p. 35. See also table 1, appendix.

is equally true that the applicant, in this instance, is to be considered a "small" business only by comparison with the other companies in the field. And, of course, we cannot now appraise the practical aspects of the proposal or the capabilities of the applicant.

Nevertheless, if a fully balanced and wholly competitive industry is to develop, efforts must be made to insure that all practicable opportunities for the entry of the relatively small business are preserved.

B. JOINT TITANIUM VENTURES

Few other industries are so characterized by the prominence of joint ventures as is the titanium metal industry. The corporations joining to operate subsidiaries in titanium are not induced to do so by any lack of individual strength, for the firms involved are among the largest and most experienced in chemicals and metals. Prevalence of this phenomenon invites close scrutiny to determine what competitive significance may develop, for the very newness of the industry strongly suggests that the present cooperative arrangements may be transitional in character.

The following is a listing of the principal joint ventures concerned:

1. *Titanium Metals Corporation of America (TMCA).*—This corporation, formed in 1950, is jointly owned by National Lead Co. and Allegheny-Ludlum Steel Corp. National Lead Co. is a large producer of other metals and chemicals, and is one of the leading domestic companies producing titanium pigments.[86] At present, National Lead is one of the principal producers of ilmenite ores.[87] TMCA's other parent—Allegheny-Ludlum Steel Corp.—is one of the major producers of stainless and specialty steels, and holds a substantial titanium-fabrication capacity. Thus, the TMCA group, with National Lead's ore properties, TMCA's sponge and melting facilities and Allegheny-Ludlum's fabrication capacity, constitutes a loosely controlled but operationally integrated titanium business.

2. *Cramet, Inc.*—This was organized in 1953 by Crane Co.; a half interest was purchased by Republic Steel Corp. in 1956. The Crane Co., a piping, porcelain, valve and fitting company, holds a substantial interest in ore production through its participation in Marine Minerals, Inc. Republic Steel, third largest steel company, holds titanium melting and fabrication capacity. With Cramet's sponge-production capacity, this company group, like that of TMCA, constitutes an integrated operation.

3. *Rem-Cru Titanium, Inc.*—This company was formed in August 1950 by the Remington Arms Co., Inc., a subsidiary of Du Pont, and Crucible Steel Corporation of America. Du Pont is the largest American chemical company, and Crucible Steel is an important producer of specialty and stainless steels. The ore supplies and sponge capacity for this group is provided by Du Pont, with Rem-Cru confining its operations chiefly to the operation of titanium melting facilities. Crucible Steel possesses the fabrication facilities for shaping titanium ingot into usable forms. Like the two preceding groups, this loose confederation of companies makes up an integrated titanium operation.

4. *Quebec Iron & Titanium Corp.*—This company is two-thirds owned by Kennecott Copper Corp., and one-third by New Jersey

[86] Supra, p. 6.
[87] Mineral Facts and Problems, supra, pp. 908–909.

Zinc Co., Inc., both of which are large metal producers. Quebec operates a large plant at Sorel, Quebec, which produces high titanium content slag from Canadian ore. Chase Brass & Copper, a wholly owned Kennecott subsidiary, is at present experimenting in the field of fabrication. Recently, Kennecott and Allied Chemical & Dye Corp. announced plans for construction of jointly owned titanium-sponge facilities. Upon realization of these plans, this group will constitute a reasonably complete, operationally integrated factor in the industry.

5. *Mallory-Sharon Titanium Corp.*—This company was incorporated in March 1951 by P. R. Mallory Co. and the Sharon Steel Corp. as a joint subsidiary. It has fabricating facilities for the melting and rolling of titanium. Sharon Steel is one of the major steel companies in the United States producing specialty steel in sheet and strip form. P. R. Mallory also produces special metals. While this group possesses no ore supply or sponge production capacity, the subsidiary does operate at the melting and fabricating levels of the industry.

The 1956 purchase by Republic Steel of a one-half interest in Cramet, Inc., resulted in a third group of affiliated companies whose operations are vertically integrated. Thus, the position of Cramet, relative to its competitors, Du Pont and TMCA, was strengthened by association with Republic Steel. Republic's requirement for sponge provides a firm market for part of Cramet's output, enhancing Cramet's ability to compete in marketing the remainder of its production. By assuring Republic Steel a reliable source of sponge, it is in greater competitive equality with the TMCA and Du Pont groups.

For the most part, these joint ventures represent a practical working response to the necessities which brought this industry into being in such a short time. Thus, the extractive metallurgy involved in production of titanium sponge requires chemical experience. The fabricating of titanium is closely allied in techniques to the stainless-steel industry. Joint operations between corporations in these fields afforded a means to combine existing know-how with a minimum of lost time. Moreover, substantial as the companies involved may be, the requirements for both fixed and working capital are large, another pressure for joint operation. The early achievement of mobilization requirements argued the necessity of fitting together the complementary technological capacities of companies in the metals and chemical fields.

These groups are operationally integrated as a practical matter. But, in each instance, different ownership interests control different levels. Further action by way of mergers or transfer of assets would be required to establish any of these as a fully integrated operation under common ownership. In short, these groups clearly evidence the fact that the organization of the industry is still in a transitional phase.

The fact that these joint ventures exist is some evidence of a tendency toward integration. But, in view of the individual strength of the partners, it seems equally likely that strong disintegration pressures exist. If titanium develops as a profitable civilian industry, the partners might well each seek to realize a greater share of those profits for the level of the operation under its control.

No attempt is made at prediction of the course this industry may follow. It appears that there is at present sufficient independent ore.

production, and fabricating capacity so that none of these joint ventures can dominate any of the levels of the industry. Should any tendency toward integration display danger signals, effective administration of existing antitrust laws can counter the further action necessary for any dominating integration.

IV. Conclusions

The defense expansion efforts of the last 7 years in titanium have produced a new metals industry. As a result of defense needs, each producer finds a market in the defense program to absorb his output, and there is so far little possibility for price or other real competition.

It is still premature to venture a prediction on the degree of competition which will obtain in the industry when it is turned to civilian output. Civilian demand must yet be developed and substantial effort remains to perfect the technology of production and fabrication.

This much is clear—the number of companies participating in the field is large for a light-metals industry. There are a half-dozen concerns engaged in production, with a greater number at other levels. This compares quite favorably with the number of firms in other light-metals industries. Too, most of these companies have strong financial resources, appearing easily able to weather the stresses of future competition in a civilian economy.

As noted, the apparent tendency toward vertical integration is not yet a real threat and, with continued antitrust watchfulness, may not become a serious factor. Further, up to the present, there has appeared no engrossment of technology to hinder competitive development.

The small-business role in this industry remains to be realized. The factors of cost and risk will prevent small business entry into basic production. Some potential opportunity may exist for the entry of small firms in ore supply explorations and in custom fabrication. Consideration should now be given to these possibilities in further DMEA operations and in defense procurement of titanium specialty products.

On balance, however, it appears that the administration of the Defense Production Act as it has affected this infant industry has displayed no serious anticompetitive factors. On the contrary, it would appear that defense efforts have shaped the industry in a form which offers a reasonable possibility of true competition when civilian demand becomes the effective controlling factor.

PART 2. VOLUNTARY AGREEMENTS AND PROGRAMS UNDER THE DEFENSE PRODUCTION ACT

As required by the 1955 amendments to the Defense Production Act of 1950, there is set forth in this section of the report an outline of the present status of the various voluntary agreements and programs formed and approved pursuant to section 708 of that act.

There are 20 such agreements outstanding: 16 of these are Army integration committees; 1 is an Air Force Production Committee; 1, inactive at the moment, is the Maritime Administration's contribution of tanker capacity agreement; 1 is a classified agreement sponsored by the United States Information Agency; and 1, perhaps the most significant agreement, is that relating to foreign petroleum supply sponsored by the Department of the Interior.

A. VOLUNTARY AGREEMENT RELATING TO FOREIGN PETROLEUM SUPPLY

My last report, dated February 9, 1957, detailed a description of this voluntary agreement and of the plan of action thereunder. This plan authorized the formation of the Middle East Emergency Committee (MEEC), composed of United States oil companies engaged in foreign operations. It was to operate under limited antitrust immunity, to meet emergency shortages of petroleum supplies in Europe. These cooperative activities included exchange of crude oil and the sharing of transportation facilities to overcome shortages caused by the shutdown of the Suez Canal and the stoppage of pipeline traffic carrying Iraq oil to the Mediterranean.

The action contemplated was specified in four schedules, all of which were set forth in full in the appendix to my last report. These aimed at maximum use of available petroleum transportation facilities to meet Western Europe's need without undue hardship to our own national interests. The major problem created by the canal and pipeline stoppages was not one of supplies but of transportation. The tanker facilities of the free world were barely adequate to handle the movement of petroleum over the normal sea routes. Rerouting tankers from the Persian Gulf around the Cape of Good Hope to Europe would result in such a delay that in a given time these tankers could deliver to Europe little more than half the quantity of petroleum customarily delivered through the canal. Worse still, the time necessary to carry oil, normally available to tankers at the eastern Mediterranean terminus of the IPC pipelines, from Iraq around Africa to Europe, would have resulted in deliveries 75 percent below normal. Together, these shortages would amount to over 1 million barrels per day, a sum equal to one-third of Europe's requirements.

The distance for the Caribbean and the Gulf of Mexico to Europe is approximately half that from the Persian Gulf around Africa to Europe. A tanker could thus make two round trips from the Western Hemisphere in the time a single round trip from the Persian Gulf could be accomplished, and petroleum was available in large quantities in the Western Hemisphere. The obvious and apparently simple solution would be to supply Europe from the Western Hemisphere. However, individual tankers had to be rerouted and supplies found for loading at unaccustomed points. And any petroleum thus diverted to Europe must in someway be replaced to meet Western Hemisphere needs. Only by a high degree of cooperation by owners of petroleum, tankers and pipelines, by foreign oil companies, foreign governments, and our own Government could the complex normal pattern of oil production and transportation be adapted quickly to the new conditions. Without such action, our European allies would face grave hardship.

As a result of the close liaison carried out between MEEC and the Oil Industry Advisory Group (OPEG) of the 17-nation Organization for European Economic Cooperation (OEEC), which organizations were described in some detail in my last report, data was accumulated as to petroleum requirements and inventories of individual countries. Concerted efforts were then made under the schedules promulgated by the Secretary of the Interior to meet these requirements. These efforts in December brought about a rapid increase in European oil

supplies over the low that had occurred in November. The mild winter, resulting both in a diminished use of heating oil and in ice-free harbors, and curtailments enforced by various foreign governments reduced the demand for oil to a quantity little more than the deliveries effected.

The success of these cooperative activities is indicated by the fact that by April 18, 1957, information available to MEEC indicated that adequate supplies of petroleum for Western Europe and other areas affected by the Middle East petroleum stoppage were available whether or not effective use could be made of the Suez Canal. As a consequence of this improved situation, Assistant Secretary of the Interior Wormser was able to write Mr. S. P. Coleman, Chairman of MEEC, on that date suspending all schedules under the plan of action.

The present activity of the Middle East Emergency Committee is largely confined to fact-gathering with respect to the supply and demand of petroleum supplies in foreign areas, particularly directed to that in Western Europe, and liaison with OEEC and OPEG.

B. ARMY INTEGRATION COMMITTEES

In my February 9 report, I stated that the Judge Advocate General of the Army had requested of the pertinent Ordnance Commands a study of the various integration committees to determine whether each such committee should be continued in an active status, placed in a standby posture or dissolved. As a result of that study, the Judge Advocate General's Office has recommended that one of the Ordnance ammunition integration committees, the 3.5-inch Rocket Committee should be dissolved and that four other of these committees should be placed in a standby status.

While the precise language of the amendment enabling four committees to be suspended is still under discussion, there appears to be agreement on the staff level among representatives of the Department of the Army, the Director of the Office of Defense Mobilization, the Chairman of the Federal Trade Commission, and this office as to the substance of an amendment of this type. The amendment would be applicable to the integration Committees on Burster Casings, Artillery Mechanical Time Fuzes, Cartridge Cases, and Military Pyrotechnics. It would suspend the activities of these committees and also the antitrust immunity applicable thereto. It would provide, in a manner similar to that utilized in the present rules governing the contribution of tanker capacity agreement, for expeditious revitalization in the event of a national defense emergency.

Of the remaining Ordnance ammunition committees, three, the Ammunition Loading, the Propellants and Explosives, and the Small Arms Ammunition Committees, have been active in the last quarter. The agreement governing the last-named committee was amended during the quarter. Principally, this amendment broadened the scope of the committee to include 20-millimeter ammunition previously excluded from this committee's jurisdiction, and under a committee no longer in existence. Two committees, the Conventional Artillery and Mortar Shell and the Fin Stabilized Artillery Ammunition Committees, have not held meetings in the last quarter. Their continuance in an active status is recommended by the Department of the Army because of unsolved technical problems in the production of these ammunition items. In my opinion, their active status is warranted

since their potential contributions to the national defense outweigh any adverse antitrust considerations in those fields. There are currently six integration committees in the tank-automotive field. One, the Heavy Tactical Truck Committee, has held meetings in the last quarter. It has also admitted two new members to the committee.[88] The remaining five have scheduled meetings to be held prior to May 31. These five committees are: Light and Medium Tactical Trucks, Medium and Heavy Gun Tanks and Allied Combat Vehicles, Light Gun Tanks and Allied Combat Vehicles, Cast Armor for Tracklaying Vehicles, and Tracks for Tracklaying Vehicles.

The Army Transportation Corps is the sponsor for the Committee on Army Aircraft and Maintenance. This committee has held no meetings in the last quarter. The members of the committee, both industrial and military, have, however, been engaged in work previously recommended by the committee. Further meetings will be needed in the near future to discuss and analyze the results of this work and to appoint subcommittees for additional work.

The Critical Quartz Crystal Integration Committee is under the sponsorship of the Army Signal Corps. All companies asked to participate in this committee have become members. A previously scheduled meeting has been postponed pending completion of current research on methods of expanding the quartz-crystal production capacity of the industry within its present factories.

C. AIR FORCE PRODUCTION COMMITTEE

There still remains outstanding the Air Force's B–47 Production Committee. The mission for which this committee was created is nearing completion. The committee continues to be active, and its supervision and guidance in the production of this aircraft appears to be in the public interest.

D. CONTRIBUTION OF TANKER CAPACITY AGREEMENT

As previously reported by me, there exists a disagreement between some of the former participants in this agreement and the Maritime Administration as to the payment of fair and equitable rates in recompense for services rendered by the participants. The Maritime Administration believes that a solution to these problems is likely in the near future. Current weighing of the defense aspects of this agreement against the anticompetitive factors is simple, since no meetings or other joint activity by the participants in this plan are permitted at the present time.

E. USIA CLASSIFIED AGREEMENT

Representatives of the United States Information Agency have recently advised that this agreement, which cannot be discussed herein because of security considerations, is one of the most important and successful single operations in which that Agency is concerned. I continue of the opinion that the anticompetitive aspects of this agreement are clearly outweighed by the public interest.

Respectfully submitted.

HERBERT BROWNELL, Jr.,
Attorney General.

[88] See Federal Register, May 9, 1957, 22 F. R. 3268.

APPENDIX

TABLE 1.—*Action of Office of Defense Mobilization on applications for certificates of necessity authorizing accelerated tax amortization by concerns in the titanium industry*

Company	Purpose	TA No.	Date filed	Date approved or denied (*)	Amount certified or requested (*)	Percent certified for rapid amortization	Reason for denial
1. Mining and beneficiation:							
Florida Ore Processing	Rutile mining	6919	Mar. 31, 1951	Sept. 21, 1952	$164,000	65	
Marine Minerals, Inc. (Aiken, S. C.)	do	28154	June 23, 1954	June 9, 1955	1,142,000	65	
Hobart Bros., Corp	do	28671	Nov. 2, 1954	Jan. 21, 1955	100,000	65	
Do	do	29954	July 5, 1955	Nov. 7, 1955	200,000	65	
Total certified					1,606,000	$1,043,900	
2. Titanium sponge production:							
Du Pont	Sponge plant	2594	Feb. 8, 1951	Apr. 24, 1951	1,227,000	90	
TMCA	do	4107	Mar. 12, 1951	May 4, 1951	14,162,840	90	
Du Pont	do	11462	June 1, 1951	June 25, 1952	9,595,800	90	
Cramet	do	24072	Jan. 6, 1953	Apr. 9, 1953	24,950,000	90	
UCC	do	28305	July 30, 1954	Sept. 27, 1954	31,500,000	90	
Du Pont	do	29016	Jan. 21, 1955	Mar. 22, 1955[1]	40,000,000	90	
Harvey	do	27745	Mar. 23, 1954	Oct. 25, 1956*	*[2] 24,842,000		Expansion goal closed.
National Distillers	do	29912	June 28, 1955	do*	*2,050,000		Do.
Columbia Titanium Co	do	30288	Aug. 1, 1955	do*	*10,500,000		Do.
Total certified					81,435,640	$73,292,076	
3. Melting capacity:							
Rem-Cru	Furnace and handling equipment	8767	Apr. 26, 1951	Dec. 6, 1951	124,033	65	
Mallory-Sharon	Buildings, furnaces, electrode presses, etc.	27379	Dec. 29, 1953	May 10, 1954	3,986,614	90	
Rem-Cru	Combination forging and electrode presses.	28112	June 14, 1954	Aug. 8, 1954	40,000	90	
Do	Buildings, furnaces, rectification equipment, etc.	28113	do	do	5,850,000	75	
Mallory-Sharon	Buildings, furnaces, auxiliary equipment.	8160	Apr. 13, 1951	June 14, 1954[3]	*2,146,670		
Republic	Melting facilities	28866	Dec. 23, 1954	Aug. 22, 1955*	*16,020,800		Failure to meet dispersion requirements.
Do	do	28867	do	Oct. 12, 1955*	*7,220,000		Do.
Do	Buildings, furnaces, and other equipment.	29866	June 22, 1955	Aug. 22, 1955	2,700,000	90	

Harvey	Melting equipment	28878	Dec. 28, 1954	(4)	1,818,000		
TMCA	Rectification equipment	30786	Nov. 15, 1955	Feb. 29, 1956	129,410	90	
TMCA	Titanium-melting facilities	31291	Feb. 21, 1956	Mar. 9, 1956	658,520	90	
Republic Steel Corp	Titanium melting	31520	May 18, 1956	July 18, 1956	7,430,000	85	
TMCA	Titanium-melting facilities	31666	July 9, 1956	Aug. 1, 1956	4,500,000	90	
Mallory-Sharon	Titanium melting	31165	Apr. 13, 1951	Aug. 24, 1956	190,500	85	
Total certified					25,609,077	$21,758,636	
4. Processing facilities:							
Rem-Cru	Combination forging	28112	June 14, 1954	Aug. 18, 1954	403,000	90	
Do	Sheet rolling mills, annealing and pickling lines.	28113	do	do	6,825,000	75	
Alcoa	Forging billet heating furnaces	28133	June 17, 1954	Sept. 20, 1954	85,976	65	
Allegheny-Ludlum (Breckenridge)	Annealing, pickle line and heating furnaces.	30076	July 14, 1955	Sept. 19, 1955	1,590,000	75	
Allegheny-Ludlum (Watervliet)	Cutting, testing equipment, lathe, etc.	30077	do	do	307,000	65	
Allegheny-Ludlum (Dunkirk)	Annealing and heating furnaces	30078	do	do	397,000	65	
Mallory-Sharon	Buildings for forging and heat treating and auxiliary equipment.	8160	Apr. 13, 1951	Dec. 21, 1954 [1]	*678,692		
Harvey	Processing facilities	28877	Dec. 28, 1954	(5)	*7,020,000		
Mallory-Sharon	Sendzimer hot and cold mill and equipment.	29709	June 3, 1955	Jan. 17, 1957*	*14,520,695		Do.
Standard Pressed Steel Co	Titanium fasteners for military aircraft.	31267	Feb. 7, 1956	July 10, 1956	2,635,300	65	
Mallory-Sharon Titanium Corp	Titanium fabricating facilities	31615	Apr. 13, 1951	Aug. 24, 1956	1,267,858	85	
TMCA	Titanium processing facilities	31439	Apr. 16, 1956	Sept. 13, 1956	3,000,000	65	
Pheoll Manufacturing Co	Titanium fasteners for military aircraft.	31449	Apr. 20, 1956	Sept. 28, 1956	995,100	65	
Republic Steel Corp	Titanium processing	31521	May 18, 1956	July 18, 1956	400,000	65	
Mallory-Sharon Titanium Corp	Titanium rod and bar	31718	July 30, 1956	Dec. 14, 1956	3,607,650	65	
Babcock & Wilcox Co	Titanium processing facilities	31931	Oct. 3, 1956	Feb. 20, 1957	1,200,000	65	
TMCA	Titanium alloy sheet facilities	31950	Oct. 10, 1956	do	225,000	65	
TMCA	Titanium processing facilities	32006	Oct. 30, 1956	do	9,098,000	65	
Total certified					32,036,884	$21,883,796	
Research and development: Kennecott Titanium Development Corp.	Research and development of an iodide titanium process.	31432	Apr. 12, 1956	Feb. 6, 1957	10,290,500	60	
Total certified					10,290,500	$617,430	
Grand total certified					150,978,101	$118,595,838	

[1] Canceled at applicant's request Sept. 16, 1955.
[2] Although filed before expansion goal closed GSA's recommendation on rapid tax amortization was deferred pending outcome of negotiations for a Government expansion project.
[3] Withdrawn on Dec. 31, 1955, and transferred to TA 31615.
[4] Pending.
[5] Withdrawn on Dec. 31, 1955, and transferred to TA 31615.
[6] Withdrawn July 5, 1955.

TABLE 2.—*Certificates of necessity authorizing accelerated tax amortization of facilities in the titanium industry, classified by affiliated and nonaffiliated companies*

	Total facilities		Mining facilities		Sponge facilities		Melting facilities		Processing facilities	
	Amount	Percent of total	Amount	Percent of total	Amount	Percent of total	Amount	Percent of total	Amount	Percent of total
Total tax amortization certified	[1] $140, 687, 601		$1, 606, 000		$81, 435, 640		$25, 609, 077		$32, 036, 884	
Total all affiliated company groups	103, 807, 225	73. 8	1, 142, 000	71. 1	49, 935, 640	61. 3	25, 609, 077	100. 0	27, 120, 508	84. 7
Du Pont group: Du Pont, Rem-Cru	24, 064, 833	17. 1			10, 822, 800	13. 3	6, 014, 033	23. 5	7, 228, 000	22. 6
TMCA group: National Lead, Allegheny Ludlum	34, 067, 770	24. 2			14, 162, 840	17. 4	5, 287, 930	20. 6	14, 617, 000	45. 7
Cramet group: Crane-Republic Steel, Marine Minerals, Inc.	36, 622, 000	26. 1	1, 142, 000	71. 1	24, 950, 000	30. 6	10, 130, 000	39. 6	400. 000	1. 2
Mallory-Sharon group: P. R. Mallory-Sharon Steel	9, 052, 622	6. 4					4, 177, 114	16. 3	4, 875. 508	15. 2
Total all nonaffiliated companies	36, 880, 376	26. 2	464, 000	28. 9	31, 500, 000	38. 7			4, 916, 376	15. 3

[1] Excluded from this total is 1 research and development certificate amounting to $10,290,500.

TABLE 3.—*Titanium-sponge production, by years* [1]

[Short tons]

Year	Total	Year	Total	Year	Total
1948	[1] 10	1951	495	1954	5,370
1949	[1] 25	1952	1,075	1955	7,398
1950	[1] 75	1953	2,241	1956	[2] 14,100

[1] Source: U. S. Bureau of Mines. Titanium in 1956, Mineral Market Reports, MMS No. 2587, p. 2.
[2] Estimated.

TABLE 4.—*Production of titanium mill products*

Period	Pounds	Period	Pounds
Total calendar year 1955	3,795,190	August 1956	738,580
		September 1956	1,070,936
January 1956	617,071	October 1956	1,313,096
February 1956	596,180	November 1956	1,187,059
March 1956	845,115	December 1956	1,280,348
April 1956	788,503		
May 1956	711,027	Total calendar year 1956	10,331,729
June 1956	844,841	January 1957	1,554,342
July 1956	338,973	February 1957	1,422,880

Source: BDSA Form 263, Bureau of the Census, Industry Division, Metals and Metal Products Branch.

TABLE 5.—*Titanium sponge production capacity*

[Short tons]

Company	Original private capacity	Expansion DPA capacity	Total sponge capacity	Percent	Post-DPA and proposed expansion	Total sponge capacity: DPA and private expansion	Percent
Total, all companies	1,000	21,500	22,500	100.0	21,000	43,500	100.0
Du Pont	900	2,700	3,600	16.0	[1] 3,600	7,200	16.6
TMCA		3,600	3,600	16.0	[2] 5,400	9,000	20.7
Cramet		6,000	6,000	26.6		6,000	13.8
Dow	100	1,700	1,800	8.0		1,800	4.1
Electro-Metallurgical		7,500	7,500	33.4		7,500	17.2
National Distillers					[2] 5,000	5,000	11.5
Allied-Kennecott					[3] 7,000	7,000	16.1

[1] Already completed.
[2] Estimated to be completed by the end of 1957.
[3] Estimated to be completed by the end of 1959.

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